1 **PROCESSES JOINING INDEPENDENT CRYSTALS**

2 **PROCESSES OF GROWTH WITH A SUBSEQUENT STEP ACTING ON THE CRYSTAL TO ADJUST THE IMPURITY AMOUNT (E.G., DIFFUSING, DOPING, GETTERING, IMPLANTING)**

3 **PROCESSES OF GROWTH WITH A SUBSEQUENT STEP OF HEAT TREATING OR DELIBERATE CONTROLLED COOLING OF THE SINGLE-CRYSTAL**

4 **PROCESSES OF GROWTH FROM SOLID OR GEL STATE (E.G., SOLID PHASE RECRYSTALLIZATION)**

5 .Organic product

6 .At pressure above 1 atmosphere

7 .Using heat (e.g., strain annealing)

8 ..Of amorphous precursor

9 ..Epitaxy formation

10 ..Using temperature gradient (e.g., moving zone recrystallization)

11 **PROCESSES OF GROWTH FROM LIQUID OR SUPERCRITICAL STATE**

12 .Crucibleless process having movement of discrete droplets or solid particles to thin-film precursor (e.g., Verneuil method)

13 .Having pulling during growth (e.g., Czochralski method, zone drawing)

14 ..With a step of measuring, testing, or sensing (e.g., using TV, photo, or X-ray detector or weight changes)

15 ...With responsive control

16 ....Shape defined by a solid member other than seed or product (e.g., edge-defined film-fed growth, Stepanov method)

17 ..With contact with an immiscible liquid (e.g., LEC)

18 ...Using a sectioned crucible or providing replenishment of precursor

19 ..Forming an intended mixture (excluding mixed crystal) (e.g., doped)

20 ...Comprising a silicon crystal with oxygen containing impurity

21 ...Comprising a semiconductor with a charge carrier impurity

22 ....Forming adjoining crystals of different compositions (e.g., junction)

23 ..Shape defined by a solid member other than seed or product (e.g., edge-defined film-fed growth, Stepanov method)

24 ...Embedded in product (e.g., string-stabilized web)

25 ...Defines a product with a hollow structure (e.g., tube)

26 ...Defines a flat product

27 ....Pulling includes a horizontal component

28 ..Including non-coincident axes of rotation (e.g., relative eccentric)

29 ..Passing non-induced electric current through a crystal-liquid interface (e.g., Peltier)

30 ..With liquid flow control or manipulation during growth (e.g., mixing, replenishing, magnetic levitation, stabilization, convection control, baffle)

31 ...Including a sectioned crucible (e.g., double crucible, baffle)

32 ...Using a magnetic field

33 ...Replenishing of precursor during growth (e.g., continuous method, zone pulling)

34 ....Including significant cooling or heating detail

35 ..With a significant technique for (a) preliminary preparation or growth starting or (b) product handling or growth ending (e.g., arrangement of or crystallography of seed)

36 ..Precursor intentionally contains an excess component or a non-product appearing component (e.g., solvent, flux, crystal lattice modifier)
37 .Having moving solid-liquid-solid region
38 ..Including a step of measuring, testing, or sensing
39 ...With responsive control
40 ..Liquid precursor penetrating only a portion of a single-crystal, thereby liquefying it, and single-crystal formation therefrom which adjoins the never-liquefied portion of the single-crystal (e.g., liquid wire migration)
41 ..Precursor composition intentionally different from product (e.g., excess component, non-product forming component, dopant, non-stoichiometric precursor, travelling solvent, flux)
42 ...Product has an element in common with the unusable residual portion
43 ..Distinctly layered product (e.g., twin, SOI, epitaxial crystallization)
44 ...Adjacent single-crystal product regions separately formed (e.g., multiple non-coextensive passes of a scanning laser)
45 ...Non-planar crystal grown (e.g., ELO)
46 ..Movement includes a horizontal component
47 ..Flat, free-standing (i.e., substrate-free) product (e.g., ribbon, film, sheet)
48 ..Solid heating means contacting the liquid (e.g., immersed)
49 ..Liquid zone contacts only precursor and product solids (e.g., crucibleless, liquid encapsulant, float zone)
50 ...Liquefying by energy from an electromagnetic wave or electromagnetic particle or arc or plasma (e.g., radiant heat)
51 ....Electromagnetic induction
52 .....With liquid control (e.g., vibration damping, stabilizing, melt levitation focusing coil)
53 .Forming a single-crystal region by liquefying a region of a single-crystal and adjusting the composition of the liquid (e.g., alloying, regrowth)
54 .Liquid phase epitaxial growth (LPE)
55 ..With a step of measuring, testing, or sensing
56 ..Including change in a growth-influencing parameter (e.g., composition, temperature, concentration, flow rate) during growth (e.g., multilayer or junction or superlattice growing)
57 ...Including a sliding boat system
58 ..With pretreatment of epitaxy substrate (e.g., autodoping control, cleaning, polishing, leveling, masking)
59 ..Including a tipping system (e.g., rotation, pivoting)
60 ..Including a vertical dipping system
61 ..Including a sliding boat system
62 ..Electric current controlled or induced growth
63 ..Characterized by specified crystallography of the substrate
64 ..Precursor composition intentionally contains an excess component or a non-product appearing component (e.g., solvent, flux)
65 ...Having an element in common
66 ....Excess component or non-product appearing component contains an oxygen atom (e.g., hydrothermal)
67 ....Excess component or non-product appearing component contains a metal atom

68 .Having growth from a solution comprising a solvent which is liquid at or below 20 degrees Celsius (e.g., aqueous solution)
69 ..With a step of measuring, testing, or sensing
70 ..Growth accompanied by material removal (other than the product) from solution (e.g., solvent evaporation, osmosis)
71 ..At pressure above 1 atmosphere (e.g., hydrothermal processes)
72 ...Quartz ($SiO_2$) product
73 .Havin growth from molten state (e.g., solution melt)
74 ..Including change in a growth-influencing parameter (e.g., composition, temperature, concentration, flow rate) during growth (e.g., multilayer or junction or superlattice growing)
75 ..Forming a platelet shape or a small diameter, elongate, generally cylindrical shape (e.g., whisker, fiber, needle, filament) (e.g., VLS method)
76 ..Using a scavenger agent (e.g., remove, add, deplete, or redistribute impurity or dopant)
77 ..Gas or vapor state precursor or overpressure
78 ..Precursor composition intentionally different from product (e.g., excess component, non-product forming component, dopant, non-stoichiometric precursor, solvent, flux)
79 ...Unusable portion contains a metal atom (e.g., diamond or CBN growth in metal solvent)
80 ...Unusable portion contains an oxygen atom (e.g., oxide flux)
81 ..Growth confined by a solid member other than seed or product (e.g., Bridgman-Stockbarger method)
82 ...Including vertical precursor-product interface (e.g., horizontal Bridgman)
83 ...Having bottom-up crystallization (e.g., VFG, VGF)
84 **FORMING FROM VAPOR OR GASEOUS STATE (E.G., VPE, SUBLIMATION)**
85 .With a step of measuring, testing, or sensing
86 ..With responsive control
87 .Forming a platelet shape or a small diameter, elongate, generally cylindrical shape (e.g., whisker, fiber, needle, filament)
88 .With decomposition of a precursor (except impurity or dopant precursor) composed of diverse atoms (e.g., CVD)
89 ..Including change in a growth-influencing parameter (e.g., composition, temperature, concentration, flow rate) during growth (e.g., multilayer or junction or superlattice growing)
90 ...With pretreatment of substrate (e.g., coacting ablating)
91 ...With a chemical reaction (except ionization) in a disparate zone to form a precursor
92 ...Using an energy beam or field, a particle beam or field, or a plasma (e.g., ionization, PECVD, CBE, MOMBE, RF induction, laser)
93 ...With significant flow manipulation or condition, other than merely specifying the components or their sequence or both
94 ..With pretreatment or preparation of a base (e.g., annealing)
95 ...Coating (e.g., masking, implanting)
96 ....For autodoping control
97 ...Material removal (e.g., etching, cleaning, polishing)
98 ..With a movement of substrate or vapor or gas supply means during growth (e.g., substrate rotation)
99 ..With a chemical reaction (except ionization) in a disparate zone to form a precursor (e.g., transport processes)

100 ...Fully-sealed or vacuum-maintained chamber (e.g., ampoule)
101 ..Characterized by specified crystallography or arrangement of substrate (e.g., wafer cassette, Miller index)
102 ..With significant flow manipulation or condition, other than merely specifying the components or their sequence or both
103 ..Using an energy beam or field, a particle beam or field, or a plasma (e.g., ionization, PECVD, CBE, MOMBE, RF induction, laser)
104 ..Using an organic precursor (e.g., propane, metal-organic, MOCVD, MOVPE)
105 .Including change in a growth-influencing parameter (e.g., composition, temperature, concentration, flow rate) during growth (e.g., multilayer or junction or superlattice growing)
106 .With pretreatment or preparation of a base (e.g., annealing)
107 .With movement of substrate or vapor or gas supply means during growth
108 .Using an energy beam or field, a particle beam or field, or a plasma (e.g., MBE)
109 .Fully-sealed or vacuum-maintained chamber (e.g., ampoule)
200 **APPARATUS**
201 .With means for measuring, testing, or sensing
202 ..With responsive control means
203 ..With a window or port for visual observation or examination
204 .With means for treating single-crystal (e.g., heat treating)
205 .For forming a platelet shape or a small diameter, elongate, generally cylindrical shape (e.g., whisker, fiber, needle, filament)
206 .For crystallization from liquid or supercritical state
207 ..Crucibleless apparatus having means providing movement of discrete droplets or solid particles to thin-film precursor (e.g., Verneuil method)
208 ..Seed pulling
209 ...Including solid member shaping means other than seed or product (e.g., EDFG die)
210 ....Means for forming a hollow structure (e.g., tube, polygon)
211 ....Including means forming a flat shape (e.g., ribbon)
212 .....Pulling includes a horizontal component
213 ...Including a sectioned crucible (e.g., double crucible, baffle)
214 ...Including details of precursor replenishment
215 ...Including sealing means details
216 ...Including a fully-sealed or vacuum-maintained crystallization chamber (e.g., ampoule)
217 ...Including heating or cooling details (e.g., shield configuration)
218 ...Including details of means providing product movement (e.g., shaft guides, servo means)
219 ..Having means for producing a moving solid-liquid-solid zone
220 ...Includin a solid member other than seed or product contacting the liquid (e.g., crucible, immersed heating element)
221 ...Havind details of a stabilizing feature
222 ...Including heating or cooling details
223 ..Shape defined by a solid member other than seed or product (e.g., Bridgman-Stockbarger)
224 ..Including pressurized crystallization means (e.g., hydrothermal)

**CROSS-REFERENCE ART COLLECTIONS**

900 **APPARATUS CHARACTERIZED BY COMPOSITION OR TREATMENT THEREOF (E.G., SURFACE FINISH, SURFACE COATING)**

901 **LEVITATION, REDUCED GRAVITY, MICROGRAVITY, SPACE**

902 **SPECIFIED ORIENTATION, SHAPE, CRYSTALLOGRAPHY, OR SIZE OF SEED OR SUBSTRATE**

903 **DENDRITE OR WEB OR CAGE TECHNIQUE**

904 **LASER BEAM**

905 **ELECTRON BEAM**

906 **SPECIAL ATMOSPHERE OTHER THAN VACUUM OR INERT**

907 .Refluxing atmosphere

910 **DOWNWARD PULLING**

911 **SEED OR ROD HOLDERS**

912 **REPLENISHING LIQUID PRECURSOR, OTHER THAN A MOVING ZONE**

913 **GRAPHOEPITAXY OR SURFACE MODIFICATION TO ENHANCE EPITAXY**

914 **CRYSTALLIZATION ON A CONTINUOUS MOVING SUBSTRATE OR COOLING SURFACE (E.G., WHEEL, CYLINDER, BELT)**

915 **SEPARATING FROM SUBSTRATE**

916 **OXYGEN TESTING**

917 **MAGNETIC**

918 **SINGLE-CRYSTAL WAVEGUIDE**

919 .Organic

920 **SINGLE-CRYSTALS HAVING A HOLLOW (E.G., TUBE, CONCAVO-CONVEX) {C30B 29/66}**

921 **SMALL DIAMETER, ELONGATE, GENERALLY CYLINDRICAL SINGLE-CRYSTAL (E.G., WHISKERS, NEEDLES, FILAMENTS, FIBERS, WIRES) {C30B 29/62}**

922 **FREE-STANDING, FLAT SINGLE-CRYSTAL (E.G., PLATELET, PLATE, STRIP, DISK, TAPE, SHEET, RIBBON) {C30B 29/64}**

923 **SINGLE-CRYSTAL OF COMPLEX GEOMETRY (E.G., PATTERNED, ELO) {C30B 29/66}**

924 **HOMOGENEOUS COMPOSITION PRODUCT WITH ENLARGED CRYSTALS OR ORIENTED-CRYSTALS (E.G., COLUMNAR)**

925 **ORGANIC COMPOUND CONTAINING SINGLE-CRYSTAL {C30B 29/54}**

926 .Tartrate containing (e.g., Rochelle salt) {C30B 29/56}

927 .Macromolecular compound containing (i.e., more than about 100 atoms) {C30B 29/58}

928 **SINGLE-CRYSTAL OF PURE OR INTENTIONALLY DOPED ELEMENT {C30B 29/02}**

929 .Carbon (e.g., diamond) {C30B 29/04}

930 .Silicon from solid or gel state {C30B 29/06}

931 .Silicon from liquid or supercritical state {C30B 29/06}

932 ..By pulling {C30B 29/06}

933 ..By moving zone (not Verneuil) {C30B 29/06}

934 ..By liquid phase epitaxy {C30B 29/06}

935 .Silicon from vapor or gaseous state {C30B 29/06}

936 .Germanium {C30B 29/08}

937 **INORGANIC CONTAINING SINGLE-CRYSTAL (E.G., COMPOUND, MIXTURE, COMPOSITE) {C30B 29/10}**

938 .Gold, silver, or platinum containing {C30B 29/52}

939 .Free metal or intermetallic compound or silicon-metal compound based, except arsenic (e.g., alloys, SiGe, InSb) {C30B 29/40, 29/52}

940 .Halide containing (e.g., fluorphlogopite, fluor-mica) {C30B 29/12}

941 .Phosphorus-oxygen bond containing (e.g., phosphate (PO4)) {C30B 29/14}

942 .Silicon-oxygen bond containing (e.g., emerald, beryl, garnet, mica) {C30B 29/16}

943 ..Quartz (SiO2) {C30B 29/18}

944 .Oxygen compound containing (e.g., yttria stabilized zirconia) {C30B 29/16}

945 ..Containing A3Me5O12 (1.5(A2O3):2.5(Me2O3)), wherein A is trivalent and selected from the group Sc, Y, La, Hf, or a rare earth metal and Me is trivalent and selected from the group Fe, Ga, Sc, Cr, Co, or Al (e.g., non-silicate garnets) {C30B 29/28}

946 ..Containing AMe2O4 (AO:(Me2O3)), wherein A is divalent and selected from the group Mg, Ni, Co, Mn, Zn, or Cd and Me is trivalent and selected from the group Fe, Ga, Sc, Cr, Co, or Al (e.g., spinels) {C30B 29/26}

947 ..Containg AMeO3 ((A2O3):(Me2O3)), wherein A is trivalent and selected from the group Sc, Y, La, Hf, or a rare earth metal and Me is trivalent and selected from the group Fe, Ga, Sc, Cr, Co, or Al (e.g., Perovskite structure, ortho-ferrites) {C30B29/24}

948 ..Niobate, vanadate, or tantalate containing {C30B 29/30}

949 ..Titanate, germanate, molybdate, or tungstate containing {C30B 29/32}

950 ..Aluminum containing (e.g., AL2O3, ruby, corundum, sapphire, chrysoberyl) {C30B 29/20}

951 .Carbide containing (e.g., SiC) {C30B 29/36}

952 .Nitride containing (e.g., GaN, cBN) {C30B 29/38}

953 .{B,Al,Ga,In,Tl}{P,As,Sb,Bi} compound containing, except intermetallics thereof (i.e., except {Al,Ga,In,Tl}{Sb,Bi}) {C30B 29/40}

954 ..Gallium arsenide containing (e.g., GaAlAs, GaAs) {C30B 29/42}

955 ..Gallium phosphide containing {C30B 29/44}

956 .{Zn,Cd,Hg}{S,Se,Te} compound containing {C30B 29/46}

957 ..CdHgTe containing {C30B 29/48}

958 ..Cadmium sulfide containing (e.g., ZnCdS) {C30B 29/50}

**FOREIGN ART COLLECTIONS**

FOR 000 **CLASS-RELATED FOREIGN DOCUMENTS**